REPORT OF WATER QUALITY IN LOWER BUCKHORN LAKE

1972

Ministry of the Environment

Ontario

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PREFACE

The Province of Ontario contains many thousands of beautiful small inland lakes which are most attractive for recreational use. Lakes close to urban areas and accessible by road often receive heavy use in terms of cottage development, camp sites, trailer parks and picnic areas.

A heavy influx of people may subject a lake and it's surrounding environment to great stress. In many cases, developments are carried out on attractive lakes only to find that when this is complete the lake qualities which were initially so appealing have been damaged. The appearance of the shoreline can be marred by construction, fishing ruined by over harvesting or the growth and decay of excessive amounts of algae and weeds. Motor boats introduce noise and petroleum pollution. Inadequate disposal of human wastes can place a great stress on the lake environment.

The accepted custom of having "a place at the lake" continues to apply pressure for more development, giving rise to an even greater expansion of problems.

The Ontario Ministry of the Environment is attempting to bring some of these stress factors under control with a variety of programs. The cottage pollution control program was initiated in 1967 and was expanded in 1970 in order to solve the cottage waste disposal problem in recreational lakes. There are three on-going studies carried out by the Ministry:

1. Evaluation of existing waste disposal systems and enforcement of repairs to those found to be unsatisfactory;
2. Research to improve the knowledge of septic tank operation and effects in shallow soil areas and evaluation of alternative methods of private

waste disposal;

3. Evaluation of present water quality in a number of recreational lakes. A totally undeveloped lake near Huntsville was studied in 1972, in order to obtain more information about natural water quality conditions within a Precambrian Lake, which would assist in defining any unnatural conditions encountered in the developed lakes surveyed.

This report on Lower Buckhorn Lake is one of a series dealing with the water quality aspects of the recreational lakes studied in 1972. As well as defining the present status of water quality in the lakes, the data are meant to provide an historical reference for comparison of conditions at any future time.

SUMMARY

Surveys were carried out in Lower Buckhorn Lake in 1972 in May, July, and October, to evaluate the present status of the water quality with respect to bacteria, algae, mineral chemistry, nutrients and dissolved oxygen concentrations.

Lower Buckhorn Lake is located in Harvey and Smith townships, County of Peterborough. The north shore of the lake lies along the southern extent of the Precambrian Shield. This area is characterized by rocky outcrop and shallow overburden covering the bedrock. The rest of the lake lies within the Trenton Black River Geological Region and is characterized by shallow soil over a limestone bedrock. The topography is generally flat with little rocky outcrop.

The overall bacteriological water quality for recreational use was generally good with the exception of two areas. The inflow area of the Mississagua River and the heavily cottaged Deer Bay Creek area appeared to be affected by bacterial inputs.

The moderately enriched nature of the lake was revealed by relatively high mean total Kjeldahl nitrogen and total phosphorus concentrations - two nutrients critical to aquatic plant and algae growth. Densities of suspended algae, as measured by chlorophyll a cncentrations were moderately high and water clarity was fairly poor.

Bottom water depletion of dissolved oxygen to levels of 15 to 25 percent saturation were observed during the summer survey.

PURPOSE OF THE SURVEYS

The surveys were designed, and tests selected in order to evaluate the present conditions in the lakes with respect to:

- concentration of bacteria
- plant nutrients and algae
- water quality with depth
- inventory of shoreline development

As a result of human activity in the recreational lake environment, some wastes may reach the lake itself and this can lead to either or both of two major types of water quality impairment, microbial contamination and excessive growths of algae and aquatic plants. The two problems can result from a common or different source of pollution, but the consequences of each are quite different.

Microbial contamination by raw or inadequately treated sewage does not significantly change the appearance of the water but poses an immediate public health hazard if the water is used for drinking or swimming. This type of pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions since most disease causing bacteria do not persist in the lake.

Nutrient enrichment, or eutrophication, results from the addition of plant fertilizers which occur naturally and are also present in virtually all forms of raw or treated human wastes. High concentrations of these fertilizers (plant nutrients), mainly nitrogen and phosphorus support extensive growths of rooted aquatic plants and of microscopic free-floating plants called

algae. Eutrophication greatly affects the lake appearance but generally does not pose a health hazard. Problems due to nutrient enrichment are generally long lasting and may become irreversible.

Changes in water temperature, dissolved oxygen and quality with depth are very important characteristics of a lake and were examined in the surveys.

Aquatic weed beds provide shelter and food for many kinds of fish. Too much growth is undesirable since it can upset the oxygen balance in the lake and can interfere with recreational uses of the lake.

DESIGN OF THE SURVEYS

Timing

Five day bacteriological, chemical and biological surveys were carried out from May 17 to 21, from July 17 to 21 and from October 3 to 7.

A proper estimation of the bacterial population requires several measurements over a period of time which can then be averaged as a geometric mean. Measurements over 5 consecutive days at each station are regarded as the minimum number which will give reliable bacterial data.

Chemical samples were collected on the first and last days of the surveys at inlet and outlet stations and at the mid-lake stations. Chlorophyll samples were collected each day at the inlet and mid-lake stations.

Selection of Sample Locations

Thirty-four bacteriological sample sites were established over the whole lake. Chemical samples were collected at two inlets, one outlet and at four mid-lake stations. In addition to these surface samples chemical and bacteriologi-

cal samples were taken from the bottom water at the mid-lake stations.

Field Tests

The variation in temperature and dissolved oxygen values with depth were measured at the four deep water stations with an electronic probe lowered into the lake and water clarity was measured with a Secchi disc (Figure 1). The pH and conductivity of the samples were measured in the field.

Bacteriological Tests

Three groups of bacteria were determined on each sample: total coliforms, fecal coliforms, fecal streptococci. These organisms are used as "indicators" of fecal contamination. Many diseases common to man can be transmitted by feces, consequently, the probability of occurrence of these diseases is usually highest in areas where the water is contaminated. The total coliforms, fecal coliforms and fecal streptococci organisms are all indigenous to man and other warm blooded animals and are found in the colon and feces in tremendous numbers. These indicator organisms in the water denote the presence of fecal contamination and hence the risk of disease causing organisms.

Chemical Tests

Hardness, alkalinity, chloride, iron and conductivity were measured in order to define the mineral composition of the water. The types of plants and animals which thrive, effects of toxic materials and suitability of the lake for various management techniques depend on the mineral content.

Total and soluble phosphorus were measured in the inlet and bottom water samples while total phosphorus only was measured in the mid-lake

The "Secchi Disc Reading" is obtained by averaging the depth at which a 23cm (9") dia. black and white plate, lowered into the lake just disappears from view and the depth where it reappears as it is pulled up.

Most of the free-floating algae are suspended in the illuminated region between the lake surface and 2 times the Secchi disc reading.

Clear, algae-free lake: Secchi disc readings tend to be greater than 3m (9 feet).

Turbid or algae-rich lake: Secchi disc readings tend to be less than 3m (9 feet).

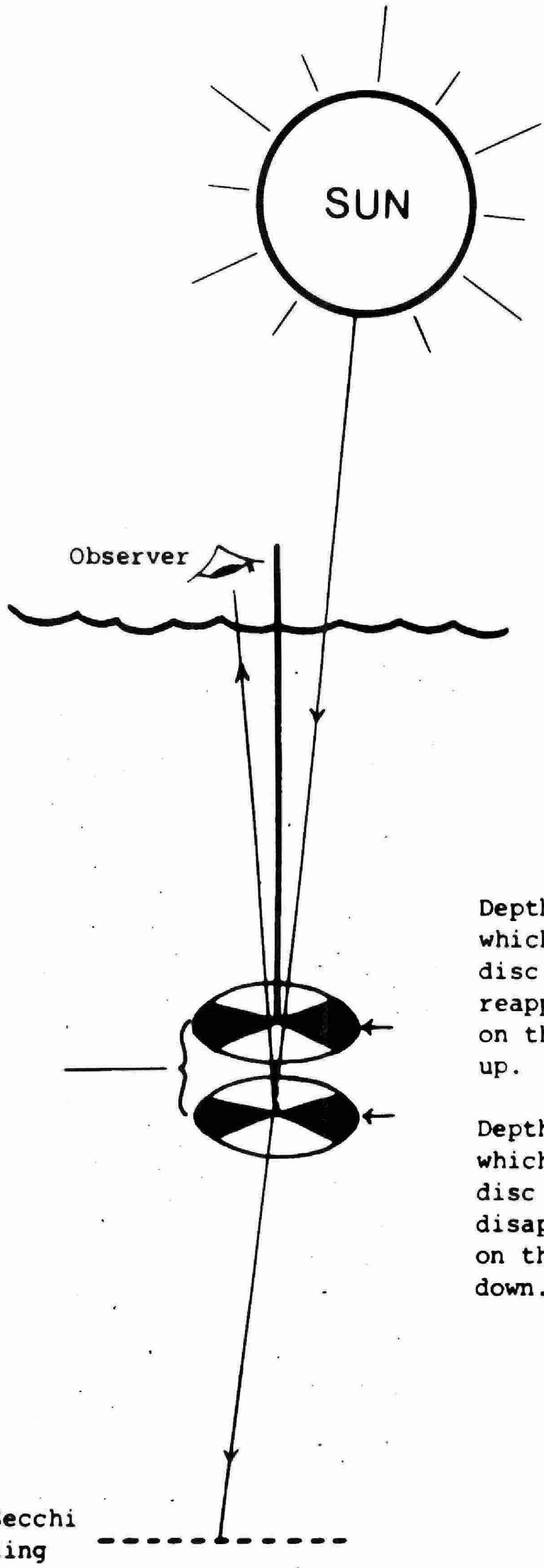


FIGURE 1: USE OF THE SECCHI DISC TO DETERMINE WATER CLARITY

and outlet surface samples. Soluble phosphorus concentrations are used mainly to substantiate various interpretations of the total phosphorus concentrations.

The total Kjeldahl nitrogen is essentially the amount of nitrogen contained in organic material. It was measured in all of the chemical samples. The soluble forms of nitrogen, ammonia, nitrite and nitrate were measured in the inlet and bottom water samples. They are particularly important in bottom waters since nitrogen may be regenerated from decaying organic matter in these forms.

Chlorophyll a concentrations are an indication of the amount of suspended algae in the water. The live algae are confined mainly to the illuminated surface waters which extend down to a depth of about twice the Secchi disc reading. The clorophyll samples were collected by raising the sample bottle through the depth of the illuminated surface waters as it filled. The sample was then representative of the algal density through the sampling depth.

AREA DESCRIPTION OF LOWER BUCKHORN LAKE

Soil and Lake Characteristics

Lower Buckhorn Lake is located in the townships of Harvey and Smith in the County of Peterborough and lies in the Lower Kawartha Lakes watershed which is part of the Trent River Drainage Basin. Its immediate watershed covers an area of 250 square kilometers (97 square miles). The lake has four main inlets:

1) Buckhorn Lake, the major inlet, flows into the west end of Lower Buckhorn Lake via lock 31 and an adjacent dam,

2) The Mississagua River, with headwaters formed by Lake Catchacoma's immediate drainage basin, empties into the west end of the lake,

3) Deer Bay Creek which drains several small lakes and flows into Black Duck Bay of Lower Buckhorn Lake,

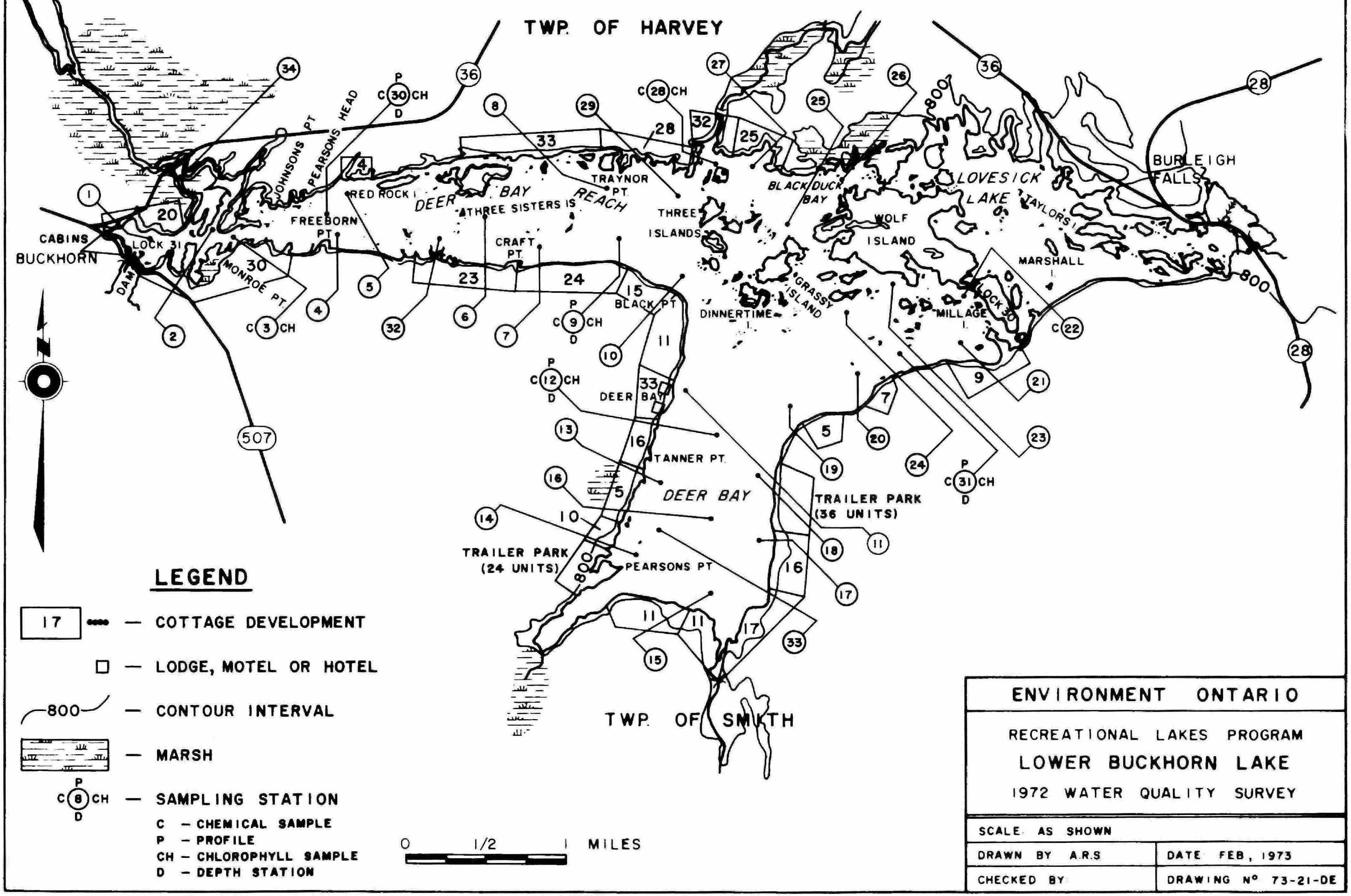
4) The last inlet flows into the south-east end of Deer Bay and drains Moore Lake.

The only outlets from the lake flow via five dams and lock 30 into Lovesick Lake. All of the dams and lock 30 are interspaced by islands (Figure 2).

Lower Buckhorn Lake is part of the Trent Canal System. It has a surface area of 13 square kilometers (5 square miles) and a shoreline length of 60 kilometers (37 miles). It is a shallow lake with a maximum depth of 10 meters (32 feet) and a mean depth of approximately 5 meters (16 feet).

The area surrounding Lower Buckhorn Lake belongs to two main soil series - the Otonabee and Monteagle. The Otonabee series is comprised of a medium textured, sandy loam formed from glacial till, 30 to 60 centimeters (12 to 24 inches) in depth, and provides good natural drainage. The Monteagle series is found in association with Rockland on the northern shore of the lake, and is comprised of stony, sandy loam usually less than 30 centimeters (12 inches) in depth. This series is normally found in hilly terrain and provides good natural drainage.

FIGURE 2 - COTTAGE DEVELOPMENT AND CONTOURS OF LOWER BUCKHORN LAKE



In addition to these two soil series there are small areas of the Muck series, comprised of 37 centimeters (15 inches) or more of poorly-drained decomposed organic material overlying a layer of mineral soils.

Water Usage

A majority of the cottagers use the lake as their source of domestic water supply. It is used for recreational purposes such as boating, fishing, water skiing and swimming as well as for winter sports.

At the present time there are no known direct discharges of raw or treated wastes into Lower Buckhorn Lake from municipal or communal sewage treatment facilities. The area residences are provided with two municipal solid waste disposal sites located within a mile of the lake. According to information from our Waste Management Branch, the site located on Lots 34 and 35, Concession XIV, Smith Township, has recently been closed down. The site located on Lot 11, Concession VI, Harvey Township appears to be satisfactory and is not posing any pollution hazards to the lake.

Shoreline Development

The shoreline of Lower Buckhorn Lake is moderately developed except for two small areas along the north-west shore. There are approximately 400 cottages, three lodges, a trailer camp and a tent camp on the lake. The Community of Buckhorn is located at the extreme west end of the lake (Figure 2).

RESULTS AND DISCUSSION

Bacteriology

The quantities of bacteriological data necessitated statistical methods to summarize the results into a concise presentation without the inconsistency associated with manual interpretation. The methods used are based on the analysis of variance and Barlett's test of homogeneity by which stations on a lake can be grouped into areas with the same bacterial level. Areas or stations with only slight differences in bacterial concentration can be isolated. It was found on previous work that areas, or stations, with significantly higher bacterial numbers generally indicated a pollution input. Details of statistical methods and data are available on request.

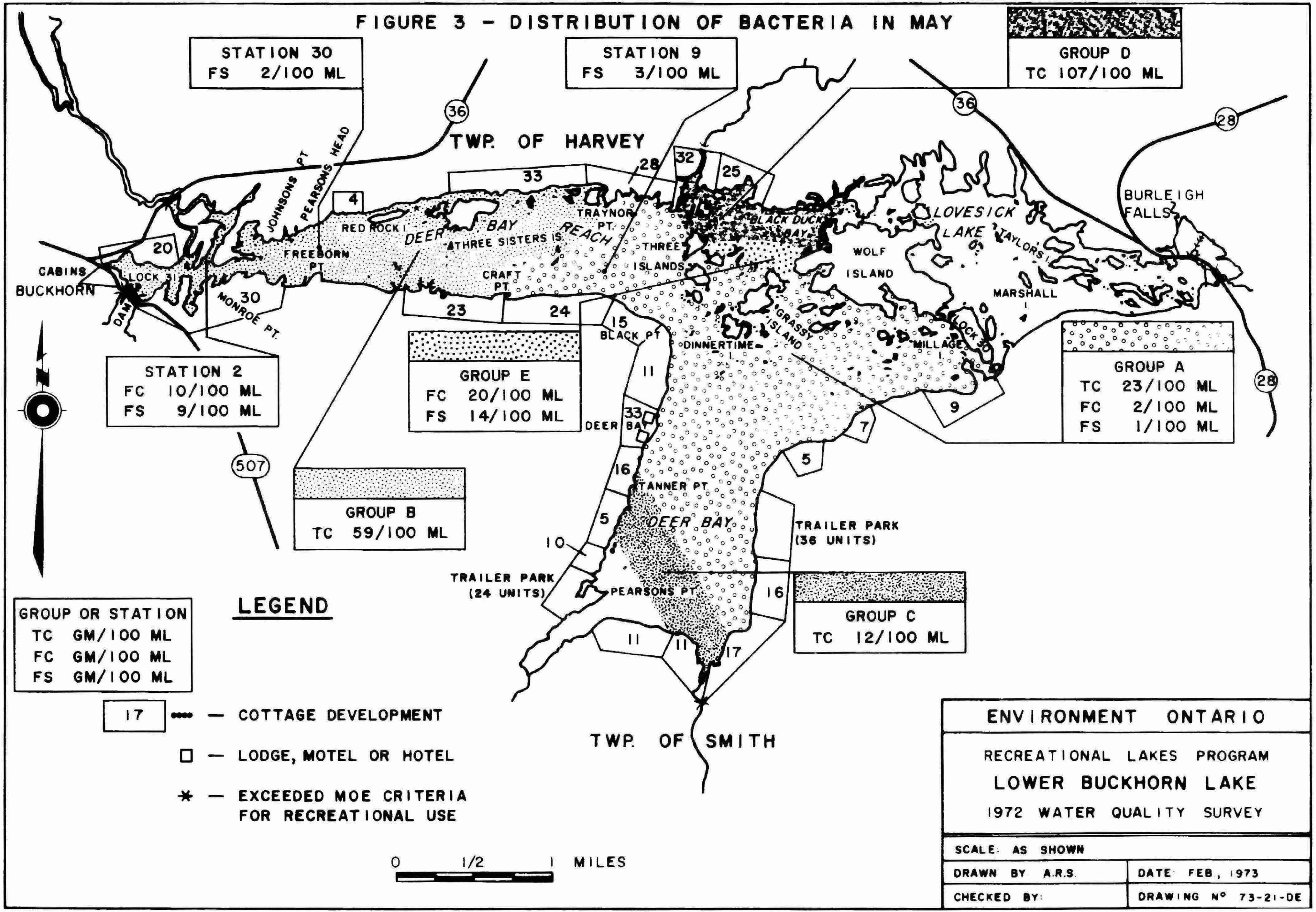
The data from the 1972 spring, summer and fall surveys indicated that, with the exception of the western end of the lake in the summer, Lower Buckhorn Lake was within the Ministry of the Environment (MOE 1972) Criteria which states:

> "Where ingestion is probable, recreational waters can be considered impaired when the coliform (TC), fecal coliform (FC), and/or enterococcus (FS) geometric mean density exceeds 1000, 100 and/or 20 per 100 ml respectively,....". (1)

In May the overall geometric means for most Stations (Group A) were 23TC, 2FC, and 1FS/100 ml (Figure 3). The northern area of Lower Buck-

(1) Guidelines and Criteria for Water Quality Management in Ontario. MOE 1972.

FIGURE 3 - DISTRIBUTION OF BACTERIA IN MAY

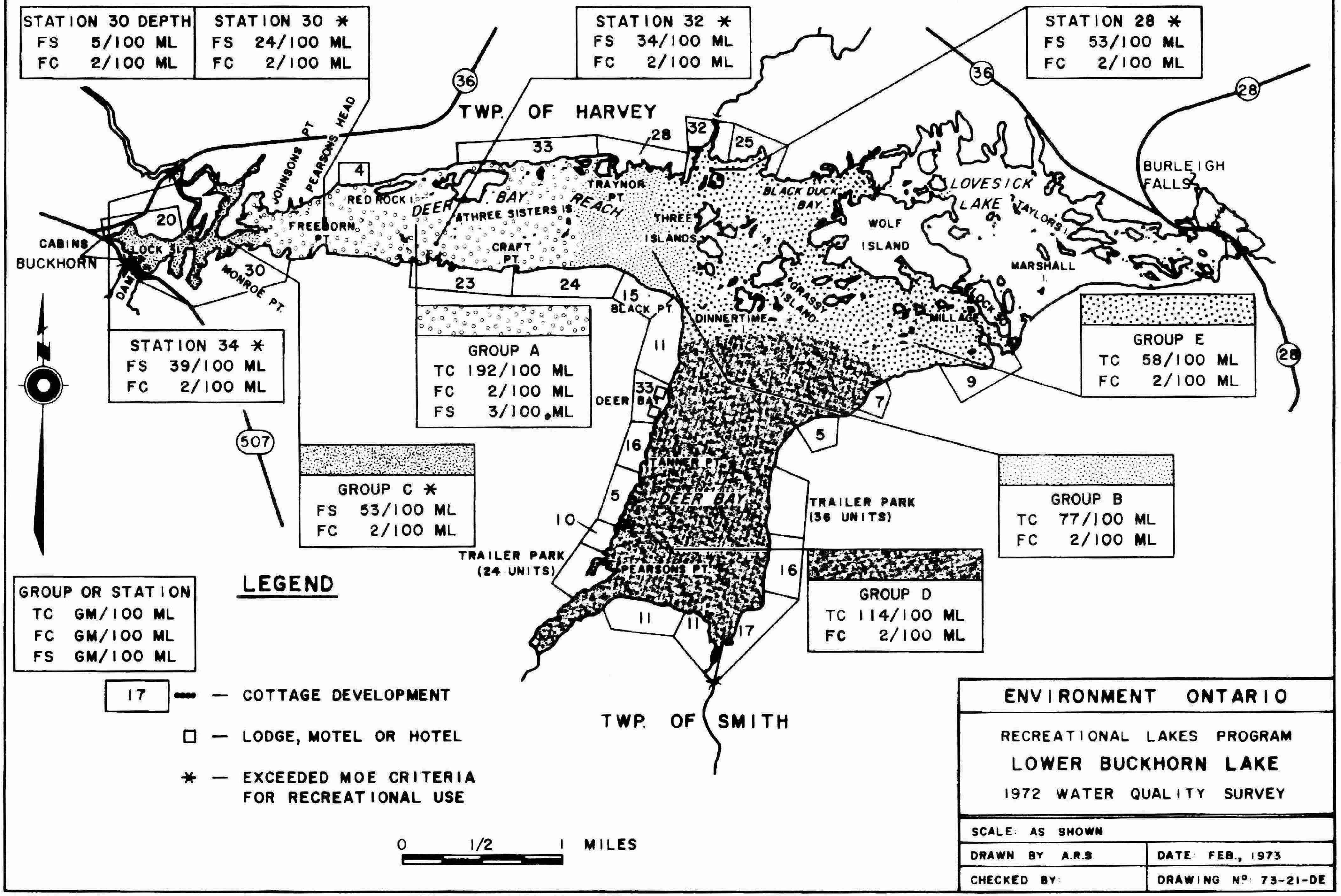


horn Lake around Black Duck Bay (Group D) had 107 TC, 20 FC and 14 FS/100 ml while Station 25, within group D had a slightly lower TC mean of 23/100 ml. The Black Duck Bay area appeared to be affected by a bacterial input from the Deer Bay Creek inflow at Station 28. The lightly cottaged Deer Bay Reach area at the western end of the lake (Group B) had 59 TC/100 ml and Station 2 within the influence of the Mississagua River also had higher FC and FS levels of 10 FC and 9 FS/100 ml. Group C in the southern Deer Bay revealed slightly lower bacterial levels of 12 TC/100 ml.

In July, the overall mean bacterial densities for most Stations were 2 FC and 3 FS/100 ml (Figure 4). However, the TC densities fluctuated from area to area. A mean of 192 TC/100 ml was recorded over the Deer Bay Reach area while the inflow at the extreme west end (Group C) also had 53 FS/100 ml and Station 1, near the lock, had 1,119 TC/100 ml. The Group B area at the mouth of Deer Bay Reach showed 77 TC/100 ml while the eastern and central part of Lower Buckhorn Lake showed 58 TC/100 ml. The southern Deer Bay (Group D) had 114 TC/100 ml. Station 28 within the influence of Deer Bay Creek again had higher bacterial levels with 53 FS/100 ml.

In October, TC, FC and FS means for most stations (Group A) were 85, 1 and 1/100 ml (Figure 5). The south Deer Bay showed slightly lower bacterial levels with 36 TC/100 ml which Station 28 again had high bacterial levels of 146 TC/100 ml, 14 FC/100 ml and 10 FS/100 ml. Group C in the Deer Bay Reach had 3 FS/100 ml while Group D on the south shore of the Deer Bay Reach had higher FC levels of 15/100 ml and Station 2 on the

FIGURE 4 – DISTRIBUTION OF BACTERIA IN JULY



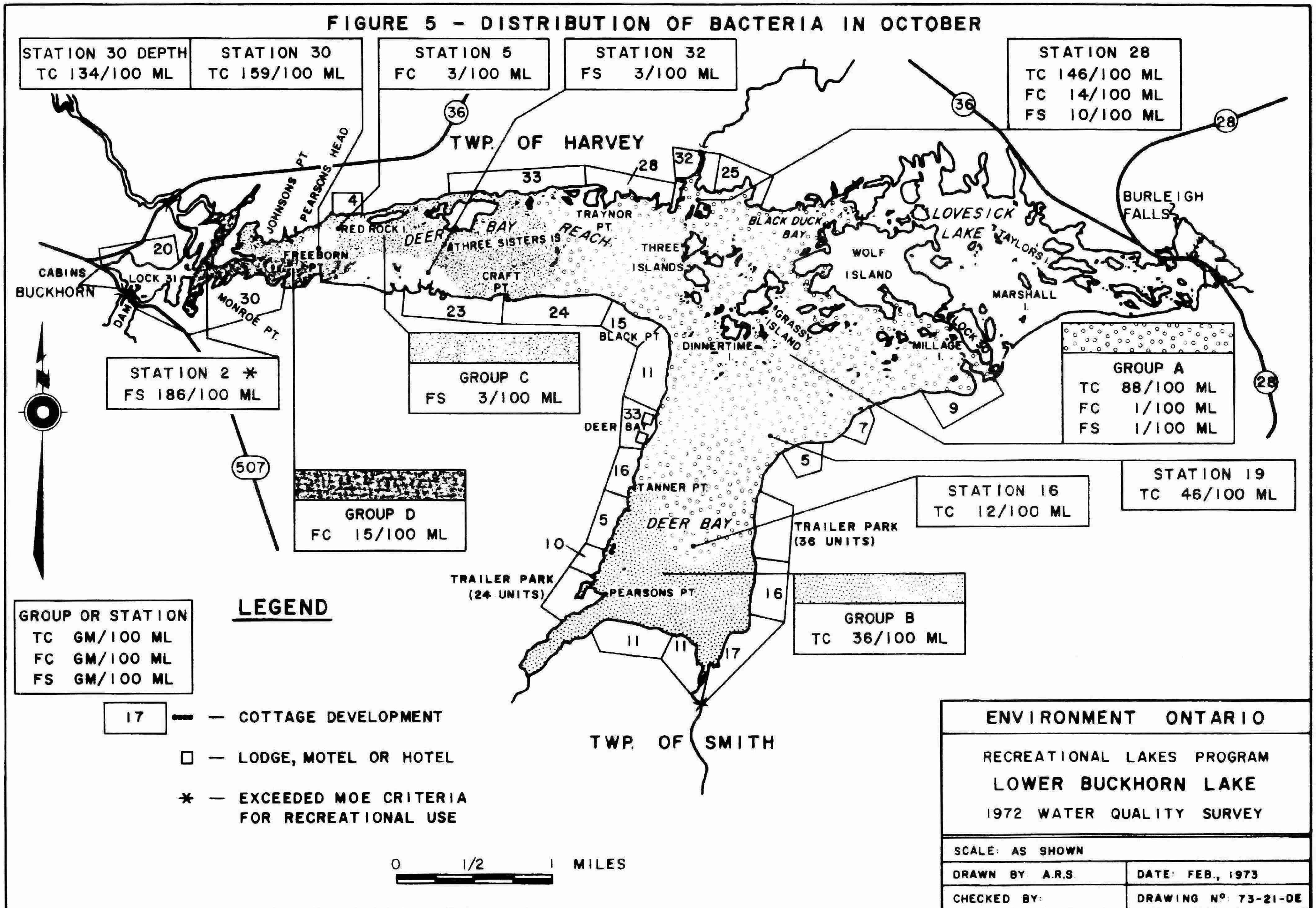


FIGURE 5 - DISTRIBUTION OF BACTERIA IN OCTOBER

Mississaugua River inflow had 186 FS/100 ml.

Only trace amounts of rain fell during the three surveys and no correlation existed between bacteria concentrations and rainfall.

Chemistry

No pronounced thermal stratification was observed in Lower Buckhorn Lake during any of the three surveys. Temperature differences between surface and bottom waters were greatest during the summer, averaging $3.7^{o}C$, while during the spring and fall surveys, the temperature difference was approximately $1^{o}C$. A greater difference existed between surface and bottom water temperatures at Station 12, in the middle of Deer Bay, which, being removed from the major water flow between Upper Buckhorn and Lovesick Lake, is not subjected to the same degree of mixing. The surface and bottom water temperatures in Deer Bay, differed by an average of $5^{o}C$ during the spring and summer and by less than $1^{o}C$ in the fall.

During the May and October surveys, dissolved oxygen concentrations never fall below 50%, and often exceeded 100% saturation at the mid-lake sampling locations. The oxygen concentrations during the summer survey ranged from 15 to 25% saturation in the bottom waters. In view of the fact that these measurements were made one meter above the bottom, the possibility exists, that the upper layer of sediments was anaerobic, which would threaten bottom dwelling, fish food organisms. However, due to the absence of pronounced thermal stratification, which would have prevented mixing, this condition is not expected to have existed long, with the possible exception of Deer Bay which does not experience the same degree of mixing as the remainder of the lake.

The alkalinity and conductivity results for the lake correlated well with variations in hardness. The water of Lower Buckhorn Lake was moderately hard with the hardness values ranging from 82 to 114 mg/l as $CaCO_3$. The mean values for alkalinity, conductivity and chloride for the mid-lake stations were 71 mg/l as $CaCO_3$, 178 umhos/cm^3 and 5 mg/l as Cl respectively. Difference in the mean values for mineral and nutrient chemistry between Lower Buckhorn Lake inflows and the lake are indicated in the table below.

	Mississagua River Inflow	Deer Bay Creek Inflow	Buckhorn Lake Inflow	Lower Buckhorn Lake (Sta.9,30 & 31)
Hardness (mg/l as $CaCO_3$)	86	52	95	91
Alkalinity (mg/l as $CaCO_3$)	66	36	75	71
Conductivity (umhos/cm^3)	168	94	189	178
Iron (mg/l)	.10	.40	.16	.08
Chloride (mg/1 as Cl)	4	3	5	5
Total Phosphorus (mg/l)	.022	.024	.029	.026
Total K-Nitrogen (mg/l)	.52	.41	.53	.49

It is noteworthy, that the mineral and nutrient concentrations in the inflow from Buckhorn were diluted by the Mississagua River reduced these concentrations to approximately the same range as the mid-lake stations on Lower Buckhorn Lake.

Mean values for Kjeldahl nitrogen (0.48 mg/l) and total phosphorus (0.024 mg/l) in the illuminated zone of Lower Buckhorn Lake reflect the moderately enriched nature of the lake Generally when total phosphorus concentrations are within the range measured on Lower Buckhorn Lake, troublesome amounts of algae and aquatic plant growth may appear. Although Lower Buckhorn Lake is to some extent naturally enriched, further inputs from agricultural runoff, and malfunctioning or improperly installed domestic waste disposal systems would accelerate the process of nutrient enrichment.

Chlorophyll a and Water Clarity

As indicated by chlorophyll a all of the deep water sampling stations were characterized by moderately high quantities of suspended algae in the illuminated zone of the lake. The concentrations of chlorophyll a ranged from 1.5 to 5.1 µg/l and averaged 4.1 µg/l over the three surveys. Water clarity, which is measured by a Secchi disc was relatively poor, having a mean value of 2.3 meters. A curve relating chlorophyll a and Secchi disc values was derived by staff of the Ministry of the Environment and illustrates the enrichment status of Lower Buckhorn Lake relative to other well known lakes in Southern Ontario (Figure 6). The moderately enriched nature of Lower Buckhorn Lake is revealed by its proximity to Chemung and Buckhorn Lakes while somewhat less enriched than Rice, Pigeon and Scugog Lakes.

Preliminary studies on lakes affected by nutrient loading from municipal waste treatment facilities have indicated improvements in water quality following either diversion of the waste effluent or phosphorus removal during the treatment process. An improvement in Sturgeon Lake water quality, in terms

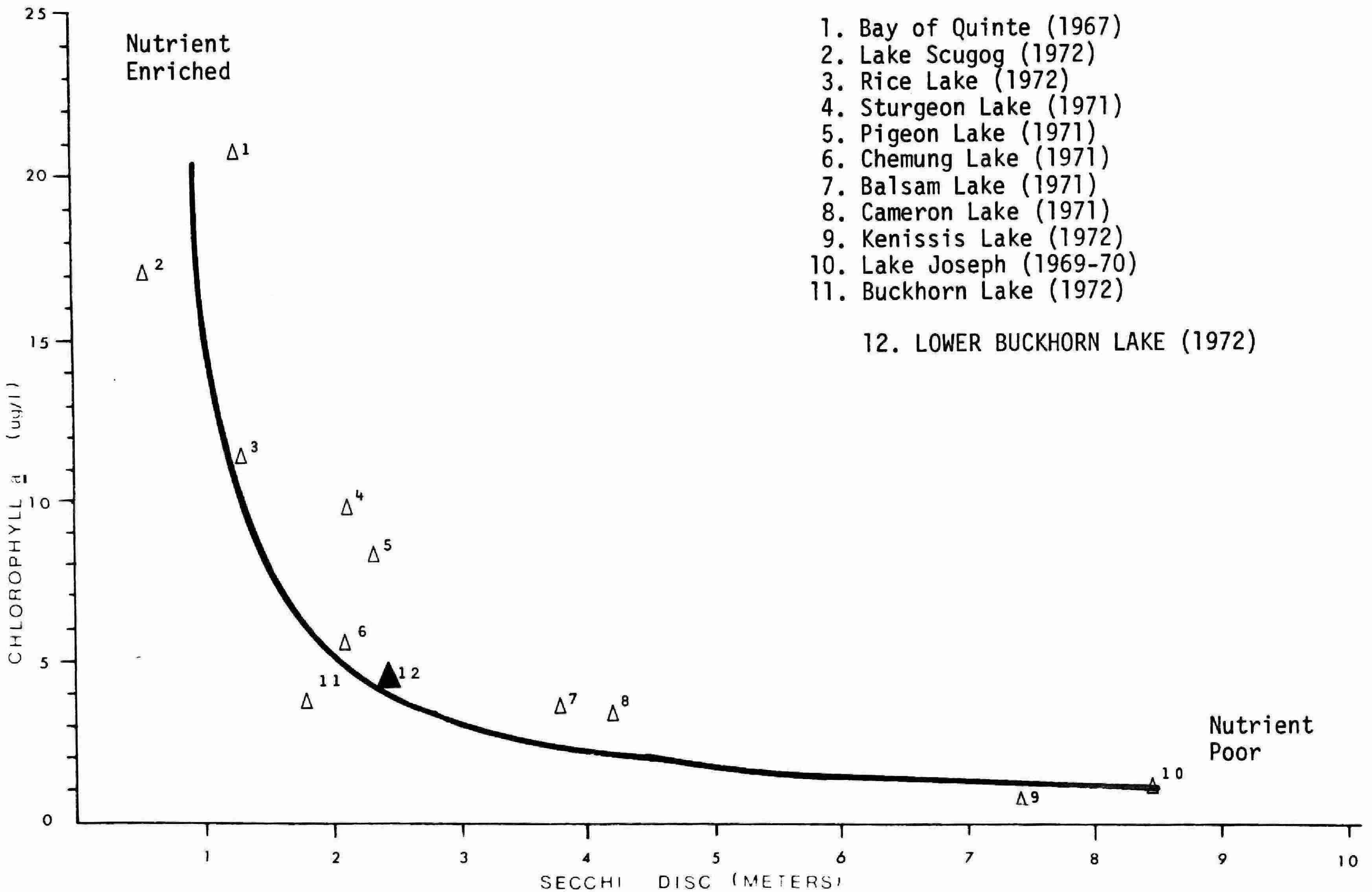


Figure 6: The mean of chlorophyll a and Secchi disc measurements in Lower Buckhorn Lake relative to a curve describing the chlorophyll a - Secchi disc relationship in many Ontario lakes. Eleven other well known lakes are included for comparison with Lower Buckhorn Lake.

of increased clarity and smaller amounts of suspended algae, will be looked for following the establishment of a phosphorus removal programme at the Lindsay waste treatment plant. Similar, but probably less noticeable improvements in Pigeon and Buckhorn Lakes may materialize as well.

INFORMATION OF GENERAL INTEREST TO COTTAGERS
MICROBIOLOGY OF WATER

For the sake of simplicity, the microorganisms in water can be divided into two groups: the bacteria that thrive in the lake environment and make up the natural bacterial flora; and the disease causing micro-organisms, called pathogens, that have acquired the capacity to infect human tissues.

The "pathogens" are generally introduced to the aquatic environment by raw or inadequately treated sewage, although a few are found naturally in the soil. The presence of these bacteria does not change the appearance of the water but pose an immediate public health hazard if the water is used fro drinking or swimming. The health hazard does not necessarily mean that the water user will contract serious waterborn infections such as typhoid fever, polio or hepatitis, but he may catch less infections of gastroenteritis (sometimes called stomach flu), dysentery or diarrhea. Included in these minor afflictions are eye, ear and throat infections that swimmers encounter every year and the more insidious but seldom diagnosed, subclinical in-fections usually associated with several water born viruses. These viral infections leave a person not feeling well enough to enjoy holidaying although not bedridden. This type of microbial pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions within a relatively short time (approximately 1 year) since disease causing bacteria ususally do not thrive in an aquatic environment.

The rest of the bacteria live and thrive within the lake environment. These organisms are the instruments of biodegradation. Any organic

matter in the lake will be used as food by these organisms and will give rise, in turn to subsequent increases in their numbers. Natural organic matter as well as that from sewage, kitchen wastes, oil and gasoline are readily attached by these lake bacteria. Unfortunately, biodegradation of the organic wastes by organisms uses correspondingly large amounts of the dissolved oxygen. If the organic matter content of the lake gets high enough, these bacteria will deplete the dissolved oxygen supply in the bottom waters and threaten the survival of many deep water fish species.

The standard plate count (SPC) populations given in the text supply an indication of the number of these bacteria in the lake.

RAINFALL AND BACTERIA

The "Rainfall Effect" referred to in the text, relates to a phenomena that has been documented in previous surveys of the Recreational Lakes. Heavy precipitation has been shown to flush the land area around the lake and the subsequent runoff will carry available contaminants including sewage organisms as well as natural soil bacteria with it into the water.

Total coliforms, fecal coliforms and fecal streptococci, as well as other bacteria and viruses which inhabit human waste disposal systems, can be washed into the lake. In Precambrian areas where there is inadequate soil cover and in fractured limestone areas where fissures in the rocks provide access to the lake, this phenomenon is particularly evident.

Melting snow provides the same transportation function for bacteria, especially in an agricultural area where manure spreading is carried out in the winter on top of the snow.

Previous data from sampling points situated 50 to 100 feet from shore indicate that contamination from shore generally shows up within 12 to 48 hours after a heavy rainfall.

WATER TREATMENT

Lake and river water is open to contamination by man, animals and birds (all of which can be carriers of disease); consequently, NO SURFACE WATER MAY BE CONSIDERED SAFE FOR HUMAN CONSUMPTION without prior treatment, including disinfection. Disinfection is especially critical if coliforms have been shown to be present.

Disinfection can be achieved by:

(a) Boiling

B oil the water for a minimum of five minutes to destroy the disease causing organisms.

(b) Chlorination Using a Household Bleach Containing 4 to 5.1/4% Available Chlorine

Eight drops of a household bleach solution should be mixed with one gallon of water and allowed to stand for 15 minutes before drinking.

(c) Continuous Chlorination

For continuous water disinfection, a small domestic hypochlorinator (sometime coupled with activated charcoal filters) can be obtained from a local plumber or water equipment supplier.

(d) Well Water Treatment

Well water can be disinfected using a household bleach (assuming

strength at 5% available chlorine) if the depth of water and diameter of the well are known.

CHLORINE BLEACH
per 10 ft depth of water

Diameter of Well Casing In Inches	One to Ten Coliforms	More than Ten Coliforms
4	.5 oz	1 oz.
6	1 oz.	2 oz.
8	2 oz.	4 oz.
12	4 oz.	8 oz.
16	7 oz.	14 oz.
20	11 oz.	22 oz.
24	16 oz.	31 oz.
30	25 oz.	49 oz.
36	35 oz.	70 oz.

Allow about six hours of contact time before using the water.

Another bacteriological sample should be taken after one week of use.

Water Sources (spring, lake, well, etc.) should be inspected for possible contamination routes (surface soil, runoff following rain and seepage from domestic waste disposal sites). Attempts at disinfecting the water alone without removing the source of contamination will not supply bacteriologically safe water on a continuing basis.

There are several types of low cost filters (ceramic, paper, carbon, diatomaceous earth sometimes impregnated with silver, etc.) that can be easily installed on taps or in water lines. These may be useful to remove particles if water is periodically turbid and are usually very successful. Filters, however, do not disinfect water but may reduce bacterial numbers. For safety, chlorination of filtered water is recommended.

SEPTIC TANK INSTALLATIONS

In Ontario, provincial law requires that you obtain permission in writing to install a septic tank system. Permission can be obtained from the local Medical Officer of Health or in some instances from the Regional Engineer of the Ministry of the Environment. Any other pertinent information such as sizes, types and location of septic tanks and tile fields can also be obtained from the same authority.

(i) General Guidelines

A septic tank should not be closer than:

-50 feet to any well, lake, stream or pond.
-5 feet to any building.
-10 feet to any property boundary

The tile field should not be closer than:

-100 feet to the nearest dug well.
-50 feet to a drilled well which has a casing to 25 feet below ground.
-25 feet to a building
-10 feet to a property boundary.
-50 feet to any lake, stream or pond.

The ideal location for a tile field is in a well drained, sandy loam soil remote from any wells or other drinking water sources. For the tile field to work satisfactorily, there should be at least 3 feet of soil between the bottom of the weeping tile trenches and the top of the ground water table or bedrock.

DYE TESTING OF SEPTIC TANK SYSTEMS

There is considerable interest among cottage owners to dye test their sewage systems, however, several problems are associated with dye testing. Dye would not be visible to the eye from a system that has a fairly direct

connection to the lake. Thus, if a cottager dye-tested his system and no dye was visible in the lake, he would assume that his system is satisfactory, which might not be the case. A low concentration of dye is not visible and therefore expensive equipment such as a fluorometer is required. Only qualified people with adequate equipment are capable of assessing a sewage system by using dye. In any case, it is likely that some of the water from a septic tank will eventually reach the lake. The important question is whether all contaminants including nutrients have been removed before it reaches the lake. To answer this question special knowledge of the system, soil depth and composition, underground geology of the region and the shape and flow of the shifting water table are required. Therefore, we recommend that this type of study should be performed only by qualified professionals.

BOATING REGULATION

In order to help protect the lakes and rivers of Ontario from pollution it is required by law that sewage (including garbage) from all pleasure craft, including houseboats must be retained in equipment of a type approved by the Ministry of the Environment. Equipment which will be approved by the Ministry of the Environment includes (1) retention devices with or without circulation which retain all toilet wastes for disposal ashore, and (2) incinerating devices which reduce all sewage to ash.

To be approved, equipment shall:

1. be non-portable,
2. be constructed of structurally sound material,
3. have adequate capacity for expected use
4. be properly installed,

5. in the case of storage devices, be equipped with the necessary pipes and fittings conveniently located for pump-out by shore-based facilities (although not specified, a pump-out deck fitting with 1.1/2 inch National Pipe Thread is commonly used).

An Ontario regulation requires that marinas and yacht clubs provide or arrange pump-out service for the customers and members who have toilet-equipped boats. In addition, all marinas and yacht clubs must provide litter containers that can be conveniently used by occupants of pleasure boats.

The following "Tips" may be of assistance to you in regards to boating:

1. Motors should be in good mechanical condition and properly tuned.
2. When a tank for outboard motor testing is used, the contents should not be emptied into the water.
3. Fuel hoses must be in good condition and all connections tight.
4. If the bilge is cleaned prior to the boating season, the waste material must not be dumped into the water.
5. Fuel tanks must not be overfilled and space must be left for expansion if the fuel warms up.
6. Vent pipes should not be obstructed and fuel needs to be dispensed at a correct rate to prevent "blow-back".
7. Empty oil cans must be deposited in a leak-proof receptacle.

ICE-ORIENTED RECREATIONAL ACTIVITIES

The Ministry of the Environment is presently preparing regulations to control pollution from ice-oriented recreational activities. In past years, there has been indiscrimate dumping of garbage and sewage on the ice. The bottoms of fish huts have been left on the ice and become a navigational hazard to boaters in the spring. Broken glass has been left on the ice only to become

injurious to swimmers. With the anticipated introduction of the regulations, many of these abuses will become illegal.

EUTROPHICATION OR EXCESSIVE FERTILIZATION AND LAKE PROCESSES

The changes in water quality brought about by excessive inputs of nutrients to lakes are usually evidenced by excessive growths of algae and aquatic plants.

Aquatic plants and algae are important in maintaining a balanced aquatic environment. They provide food and a suitable environment for the growth of aquatic invertebrate organisms which serve as food for fish. Shade from large aquatic plants helps to keep the lower water cool which is essential to certain species of fish and also provide protection for young game and forage fish. Numerous aquatic plants are utilized for food and/or protection by many species of waterfowl. However, too much growth creates an imbalance in the natural plant and animal community particularly with respect to oxygen conditions, and some desirable forms of life such as sport fish are eliminated and unsightly algae scums can form. The lake will not be "dead" but rather abound with life which unfortunately is not considered aesthetically pleasing. This change to poor water quality becomes apparent after a period of years in which extra nutrients are added to the lake and a return to the natural state may also take a number of years after the nutrient inputs are stopped. Changes in water quality with depth are a very important characteristic of a lake. Water temperatures are uniform throughout the lake in the early spring and winds generally keep the entire volume well mixed. Shallow lakes may remain well mixed all summer so that water quality will be the same throughout. On the other hand, in deep lakes, the surface waters

warm up during late spring and early summer and float on the cooler more dense water below. The difference in density offers a resistance to mixing by wind action and many lakes do not become fully mixed again until the surface waters cool down in the fall. The bottom water receives no oxygen from the atmosphere during this unmixed period and the dissolved oxygen supply may be all used up by bacteria as they decompose organic matter. Cold water fish, such as trout, will have to move to the warm surface waters to get oxygen and because of the high water temperatures they will not thrive, so that the species will probably die out (see Figure next page).

Low oxygen conditions in the bottom waters are not necessarily an indication of pollution but excessive aquatic plant and algae growth and subsequent decomposition can aggravate the condition and in some cases can result in zero oxygen levels in lakes which had previously held some oxygen in the bottom waters all summer. Although plant nutrients normally accumulate in the bottom waters of lakes, they do so to a much greater extent if there is no oxygen present. These nutrients become available for algae in the surface waters when the lake mixes in the fall and dense algae growths can result. Consequently, lakes which have no oxygen in the bottom water during the summer are more prone to having algae problems and are more vulnerable to nutrient inputs than lakes which retain some oxygen.

CONTROL OF AQUATIC PLANTS AND ALGAE

Usually aquatic weed growths are heaviest in shallow shoreline areas where adequate light and nutrient conditions prevail.

Extensive aquatic plant and algal growths sometimes interfere with

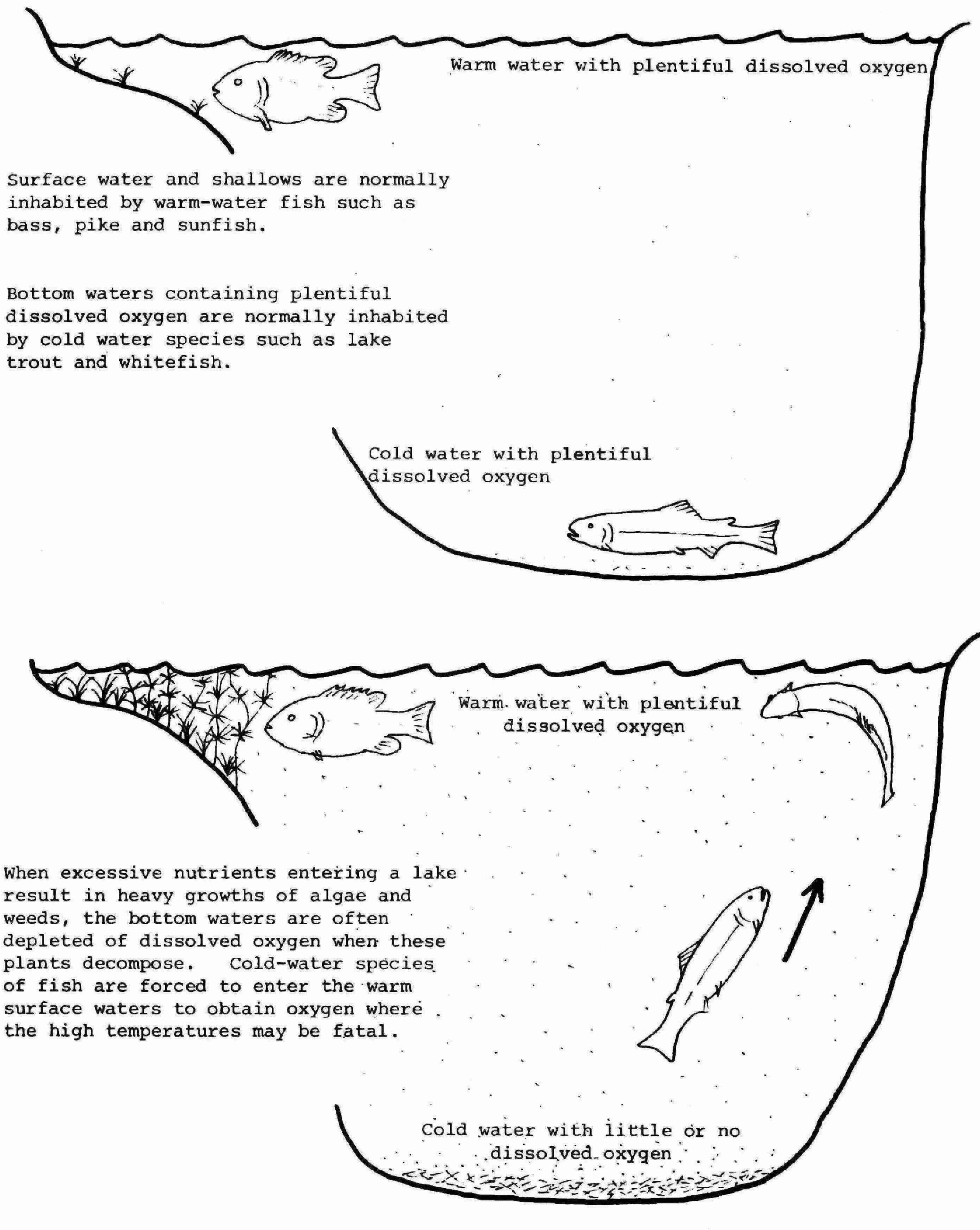


FIGURE A-1: DECOMPOSITION OF PLANT MATTER AT THE LAKE BOTTOM CAN LEAD TO DEATH OF DEEP-WATER FISH SPECIES.

boating and swimming and ultimately diminish shoreline property values.

Control of aquatic plants may be achieved by either chemical or mechanical means. Chemical methods of control are currently the most practical, considering the ease with which they are applied. However, the herbicides and algicides currently available generally provide control for only a single season. It is important to ensure that an algicide or herbicide which kills the plants causing the nuisance, does not affect fish or other aquatic life and should be reasonable in cost. At the present time, there is no one chemical which will adequately control all species of algae and other aquatic plants. Chemical control in the province is regulated by the Ministry of the Environment and a permit must be granted prior to any operation. Simple raking and chain dragging operations to control submergent species have been successfully employed in a number of situations; however, the plants soon re-establish themselves. Removal of weeds by underwater mowing techniques is certainly the most attractive method of control and is currently being evaluated in Chemung Lake near Peterborough. Guidelines and summaries of control methods, and applications for permits are available from the Biology Section, Water Quality Branch, Ministry of the Environment, Box 213, Rexdale, Ontario.

PHOSPHORUS AND DETERGENTS

Scientists have recognized that phosphorus is the key nutrient in stimulating algal and plant growth in lakes and streams.

In the past years, approximately 50% of the phosphorus contributed by municipal sewage was added by detergents. Federal regulations reduced

the phosphate content as P_2O_5 in laundry detergents from approximately 50% to 20% on August 1, 1970 and to 5% on January 1, 1973.

It should be recognized that automatic dishwashing compounds were not subject to the recently approved government regulations and that surprisingly high numbers of automatic dishwashers are present in resort areas (a questionnaire indicated that about 30% of the cottages in the Muskoka Lakes have automatic dishwashers). Cottagers utilizing such conveniences may be contributing significant amounts of phosphorus to recreational lakes. Indeed, in most of Ontario's vacation land, the source of domestic water is soft enough to allow the exclusive use of liquid dishwashing compounds, soap and soap-flakes.

ONTARIO'S PHOSPHORUS REMOVAL PROGRAM

By 1975, the Government of Ontario expects to have controls in operation at more than 200 municipal wastewater treatment plants across the province serving some 4.7 million persons. This represents about 90% of the population serviced with sewers. The program is in response to the International Joint Commission recommendations as embodied in the Great Lakes Water Quality Agreement and studies carried out by the Ministry of the Environment on inland recreational waters which showed phosphorus to be a major factor influencing eutrophication. The program makes provision for nutrient control in the Upper and Lower Great Lakes, the Ottawa River system and in prime recreational waters where the need is demonstrated or where emphasis is placed upon prevention of localized eutrophication.

Phosphorus removal facilities must be operational at wastewater treatment plants by December 31, 1973, in the most critically affected areas

of the province, including all of the plants in the Lake Erie drainage basin and the inland recreational areas. The operational date for plants discharging to waters deemed to be in less critical condition which includes plants larger than one million gallons per day (1 mgd) discharging to Lake Ontario and to the Ottawa River system, is December 31, 1975. The 1973 phase of the program will involve 156 plants of which 85 are in the Lake Erie basin and another 30 in the Lake Huron drainage basin. The capacities of these plants range from 0.04 to 24.0 mgd, serving an estimated population of 1,600,000 persons. The 1975 phase will bring into operation another 57 plants ranging in size from 0.3 to 180 mgd serving an additional 3,100,000 persons. Treatment facilities utilizing the Lower Great Lakes must meet effluent guidelines of less than 1.0 milligrams per litre of total phosphorus in their final effluent. Facilities utilizing the Upper Great Lakes, the Ottawa River Basin and certain areas of Georgian Bay where needs have been demonstrated must remove at least 80% of the phosphorus reaching their sewage treatment plants.

CONTROL OF BITING INSECTS

Mosquitoes and blackflies often interfere with the enjoyment of recreational facilities at the lake-side vacation property. Pesticidal spraying or fogging in the vicinity of cottages produces extemely temporary benefits and usually do not justify the hazard involved in contaminating the nearby water. Eradication of biting fly populations is not possible under any circumstances and significant control is rarely achieved in the absence of large-scale abatement programmes involving substantial funds and trained personnel. Limited use of approved

larvicides in small areas of swamp or in rain pools close to residences on private property may be undertaken by individual landowners, but permits are necessary wherever treated waters may contaminate adjacent streams or lakes. The use of repellents and light traps is encouraged as are attempts to reduce mosquito larval habitat by improving land drainage. Applications for permits to apply insecticides as well as technical advice can be obtained from the Biology Section, Water Quality Branch of the Ministry of the Environment, Box 213, Rexdale, Ontario.